Operating the PJM System

NRC Regulatory Information Conference

Session C1: Grid Reliability

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Regional Operations of PJM Interconnection

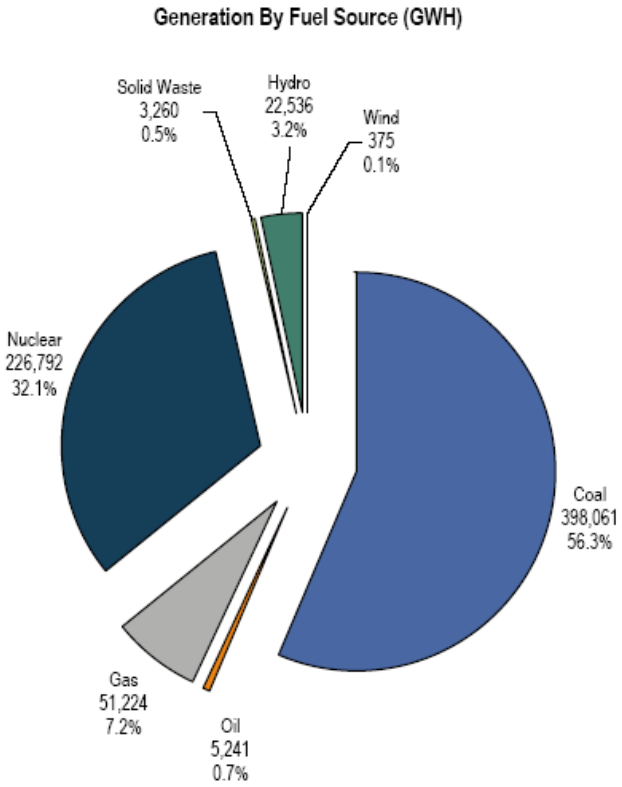
March 8, 2005

- May 1, 2004 – Commonwealth Edison
  - Installation of a 500 MW pathway between ComEd and existing PJM control areas (= 2 control areas)
- October 1, 2004 – AEP and Dayton Power and Light
  - Removal of pathway and consolidation of the control areas to one control area
- January 1, 2005 – Duquesne Light
  - Inclusion of FE Beaver Valley as a capacity resource in PJM
- Spring 2005 – Dominion

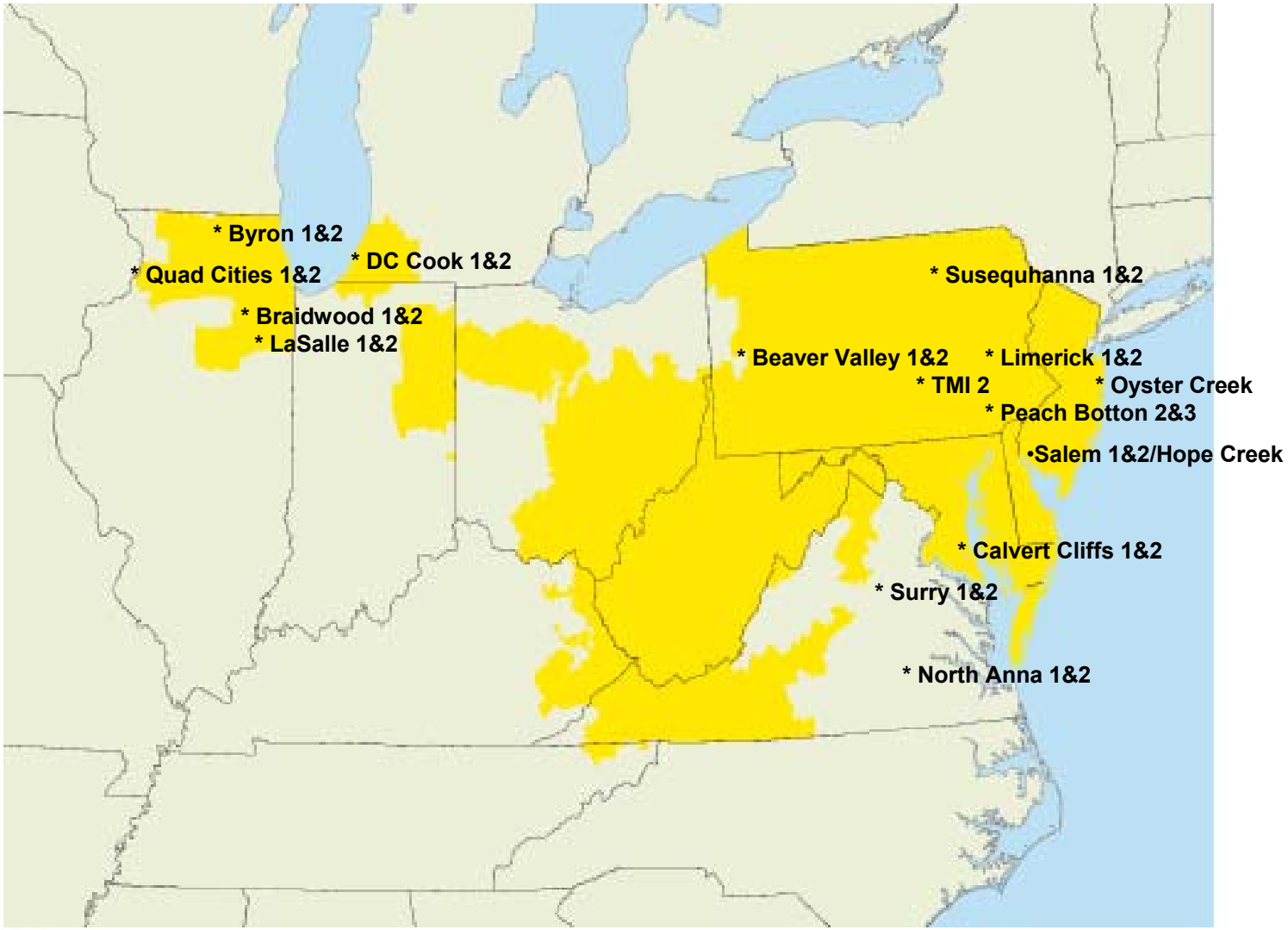
Overview of PJM—Energy Market Statistics

KEY STATISTICS*	PJM	PJM *Jan. 1 with Duquesne Light*
millions of people served	44	45.3
peak load in megawatts	107,820	110,700
megawatts of generating capacity	134,250	137,490
miles of transmission lines	49,300	49,970
generation sources	984	1001
square miles of territory	137,700	138,510
area served	12 states + D.C.	12 states + D.C.

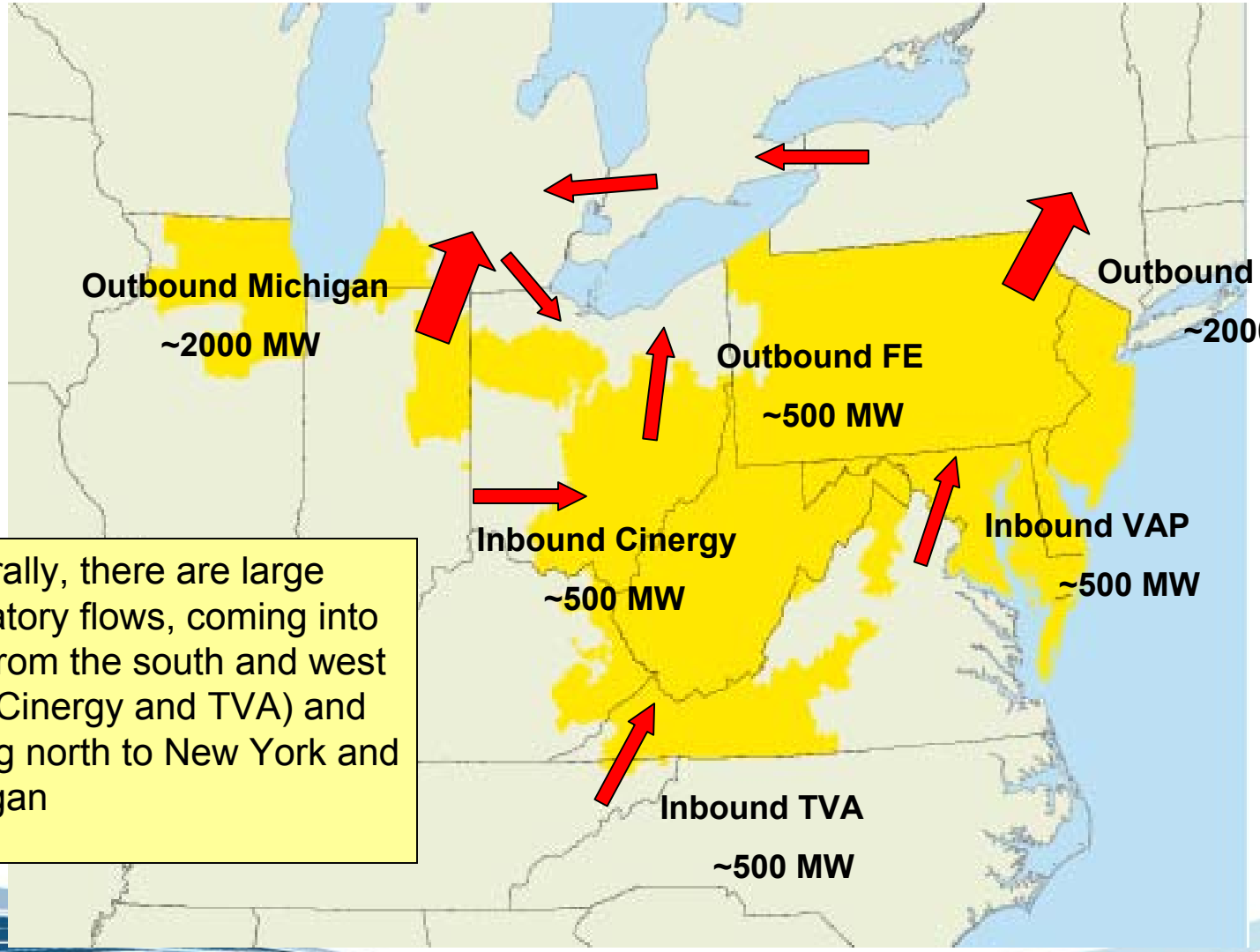
*numbers are approximate



Overview of PJM—Nuclear Plants



Review of Operations--Big Picture (Winter)



Generally, there are large circulatory flows, coming into PJM from the south and west (e.g., Cinergy and TVA) and flowing north to New York and Michigan

$$ACE = (N_{IA} - N_{IS}) - 10ß\,(F_A - F_S) - I_{ME}$$

Tie Error Component

Total difference between actual and scheduled interchange summed across the metered boundaries of PJM

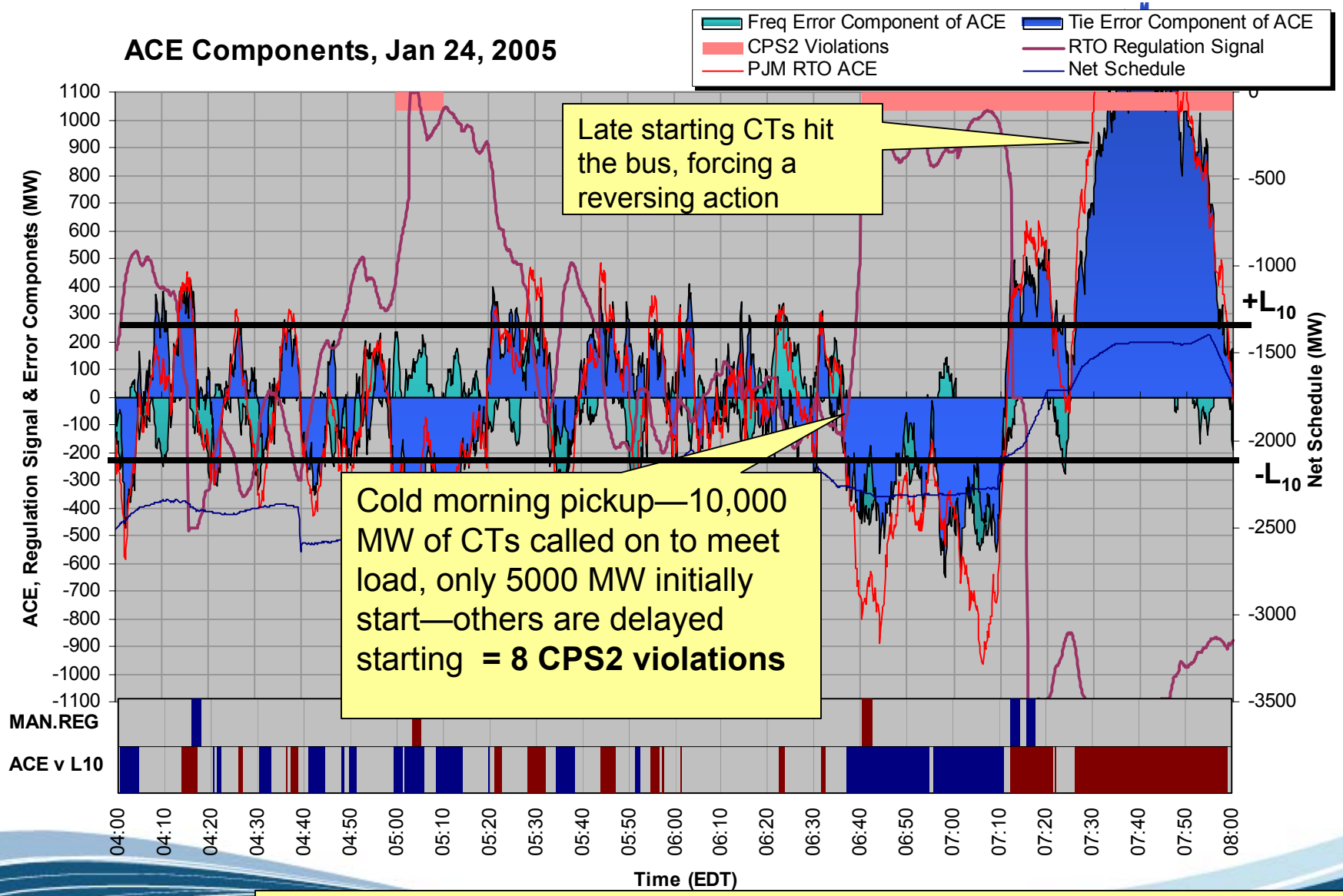
Frequency Error Component

Difference between actual frequency and scheduled frequency (normally 60 Hz)

For PJM, 1138 MW/0.1 Hz

Bottom Line: PJM must keep its average ACE within ± 258 MW for at least 90% of every 10 minute period for the month (NERC CPS-2 Control Performance Requirement)

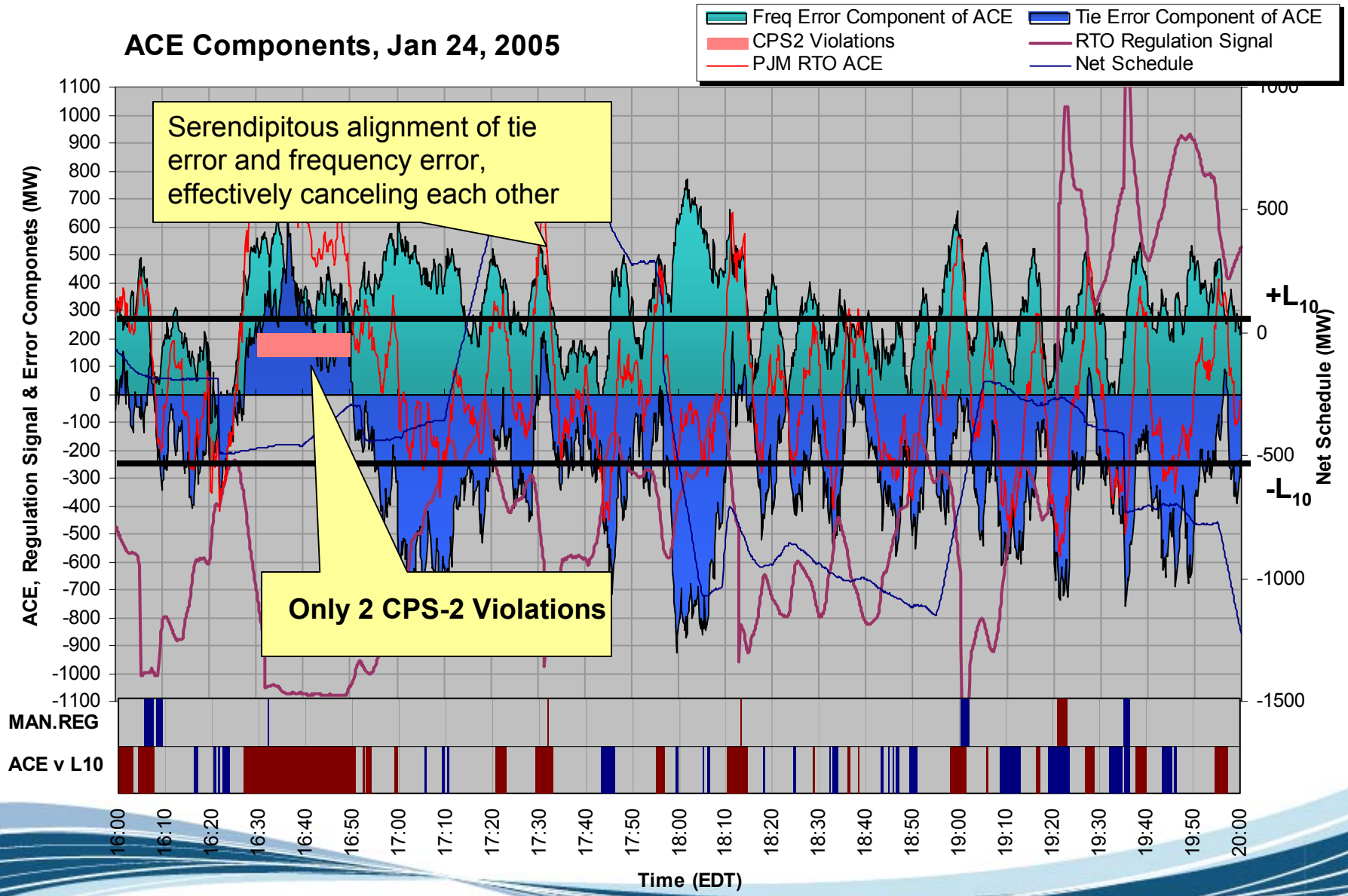
January 24 Case Study—Morning Pickup



PJM Load grew by over 20,000 MW during this 4 hr period!

January 24 Case Study—Morning Pickup

January 24 Case Study—Evening Pickup



- Created by the owners as a feature of PJM governance (PJM staff facilitates and provides administrative support)
- Broad participation from the nuclear owners: AEP, AmerGen, Constellation, Dominion, Exelon, First Energy, PPL, and PSEG

- "Cultural" Differences
  - Communications (Don't speak the same language)
  - Have differing regulatory accountabilities (FERC vs. NRC vs. State PUCs)
  - Market role (Code of Conduct issues)

Nuclear Communications Protocol (PJM Manual M-1, Attachment B)

http://www.pjm.com/contributions/pjm-manuals/pdf/m01v08.pdf

Features:

- Nuclear Safety/ Grid Reliability Philosophies
- Roles and Responsibilities
- Key Terms Defined
- Event Communications
- Regulatory Background Information

KEY TRANSMISSION TERMS

First Contingency Violation

The transmission system is operated so that the single loss of any facility (line, generator, etc.) will not result in violation of any operating limit. The single loss is called the first contingency. The transmission operators have software that simulates the first contingency individually for a number of facilities on the system.

Implication: The operators are required to correct any first contingency violation that will violate the emergency ratings on any facility within a period of time (normally within 30 minutes). If the operators ask the nuclear plant to take action as the result of the first contingency violation, the action should be implemented unless the action will jeopardize nuclear safety, personnel safety, or equipment protection.

- Post-contingency Voltage Stability
  - NPPs generally have more restrictive voltage limits than the grid
  - In an accident scenario, will the safety systems work if needed?

Notification and Mitigation Protocols for Nuclear Plant Voltage Limits (PJM Manual M-3, Section 3, page 36)

http://www.pjm.com/contributions/pjm-manuals/pdf/m03v14.pdf

Regarding Code of Conduct issues:

"If PJM operators observe voltage violations or anticipate voltage violations (pre or post-contingency) at any nuclear stations; PJM operators are permitted to provide the nuclear plant with the actual voltage at that location, the post-contingency voltage at that location (if appropriate) and limiting contingency causing the violation."

Example of Voltage Standards and Operational Philosophy

PJM BASE LINE VOLTAGE LIMITS

PJM Base Line Voltage Limits						
Limit	**500 kV**	**345 kV**	**230 kV**	**138 kV**	**115 kV**	**69 kV**
High	550 (1.10)	362 (1.05)	242 (1.05)	145 (1.05)	121 (1.05)	72.5 (1.05)
Normal Low	500 (1.00)	328 (.95)	219 (.95)	131 (.95)	109 (.95)	65.5 (.95)
Emergency Low*	485 (.97)	317 (.92)	212 (.92)	127 (.92)	106 (.92)	63.5 (.92)
Load Dump*	475 (.95)	310	207	124	103	62
Voltage Drop Warning*	2.5%					
Voltage Drop Violation*	5-8%**					

* Refer to PJM Manual for Emergen
** The voltage drop violation percenta

Exhibit 5: P

The following chart details PJM's Voltage Operating Guidelines for a Post-Contingency Simulated Operation.

Voltage Limit Exceeded	If post contingency simulated voltage limits are violated	Time to correct (minutes)
High Voltage	Use all effective non-cost and off-cost actions.	30 minutes
Normal Low	Use all effective non-cost actions.	Not applicable
Emergency Low	Use all effective non-cost actions, off-cost actions, and emergency procedures except load shed.	15 minutes
Load Dump Low	All of the above plus, shed load if analysis indicates the potential for a voltage collapse.	5 minutes
Voltage Drop Warning	Use all effective non-cost actions.	Not applicable
Voltage Drop Violation	All effective non-cost and off-cost actions plus, shed load if analysis indicates the potential for a voltage collapse.	15 minutes

- Outage Coordination
  - *NPP perspective*: Getting the transmission owner to perform maintenance when the NPP is in an outage to mitigate NPP risk
  - *Transmission perspective*: We don't schedule maintenance the way *they* do.

Outage Coordination Procedures (PJM Manual M-3, Section 4) Same link as above

- Strict advanced notification requirements
- Multiple step analysis process to ensure reliability is maintained
- Wide dissemination of outage information

Special Consideration for Nuclear Plants

The Nuclear Generating Stations coordinate the scheduling of a Unit Breaker outage and internal plant equipment outages and testing to minimize station risk. Adherence to outage schedule and duration is critical to the plant during these evolutions. Emergent plant or transmission system conditions may require schedule adjustments, which should be minimized. Any change to the outage schedule that impacts the Unit Breakers shall be communicated to the nuclear generator operator. The following Nuclear Generating Stations have transmission system connections that can impact Nuclear Station Safety Systems:

Peach Bottom:
Unit 2: CB 215
CB 225
Unit 3: CB 15
CB 65

Salem:
Unit 1: 5 – 6 B.S. 10X
2 – 6 B.S. 11X
Unit 2: 9 – 10 B.S. 30X
1 – 9 B.S. 32X

Hope Creek:
BS 6 – 5 50X
BS 2 – 6 52X

Limerick:
Unit 1: CB 535
CB 635
Unit 2: CB 235
CB 335

Oyster Creek:
GD1
GC1

Calvert Cliffs:
Unit 1: 552 – 22
552 – 23
Unit 2: 552 – 61
552 - 63